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(54) [TITLE OF THE INVENTION] THICKNESS MEASURING METHOD OF LIQUID CRYSTAL CELL

(57) [ABSTRACT]

[PURPOSE] The present invention has the purpose of obtaining a liquid crystal cell thickness measuring method enabling correct measurement of a gap.

[CONSTITUTION] A pair of glass substrates 10 having transparent electrodes 40 on their inner surfaces is bonded by a sealing material 50; at the same time, a liquid crystal 60 of positive dielectric anisotropy is injected between the pair glass substrates 10; and when the gap of the liquid crystal cell is measured, a high voltage not smaller than 50 times the threshold voltage or a high magnetic field not smaller than 50 times the threshold magnetic field is applied to the liquid crystal cell.

[CLAIMS]

[CLAIM 1] A liquid crystal cell thickness measuring method, wherein a pair of glass substrates having transparent electrodes on their inner surfaces is bonded by a sealing material; a liquid

crystal of positive dielectric anisotropy is injected between the pair glass substrates; and when a gap of the liquid crystal cell is measured, a high voltage not smaller than 50 times a threshold voltage or a high magnetic field not smaller than 50 times a threshold magnetic field is applied to the liquid crystal cell.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[INDUSTRIAL APPLICABILITY] This invention relates to a liquid crystal cell thickness measuring method for a liquid crystal display cell.

[0002]

[PRIOR ART] In the prior art liquid crystal cell structure, as shown in Figure 3, a pair of glass substrates 1 is bonded by a sealing material 2; a liquid crystal 3 is injected between the pair glass substrates 1; a detector 5 is provided above the cell; and a reflection measuring light 4b and a transmittance measuring light 4a are applied from the top side and the bottom side, respectively.

[0003] In the case where the cell thickness after the injection of the liquid crystal 3 is measured by using optical interferometry, when the measuring lights 4a and 4b contain polarization, the direction of the liquid crystal cell with regard to the polarization is determined, and the transmitted light spectrum is measured to find the optical path difference of the liquid crystal cell. The optical path difference is divided by the refractive index of the liquid crystal corresponding to the polarization direction so as to find the cell thickness.

[0004] In a cell with, for example, homogeneous orientation (refer to Figure 4), when the main axis direction of the liquid crystal molecules 3a is parallel with the polarization direction between the glass substrates 1, the above-mentioned refractive index indicates

the refractive index of the liquid crystal molecules 3a against abnormal light. On the other hand, when the main axis direction of the liquid crystal molecules 3a is orthogonal to the polarization direction between the glass substrates 1, it indicates the refractive index against normal light.

[0005]

[PROBLEMS THE INVENTION IS GOING TO SOLVE] In a cell having homogeneous orientation, the refractive index of the cell can be defined by determining the direction of the main axis; however, in the case of a TN cell (refer to Figure 5) or a STN cell (refer to Figure 6), since the spatial distribution of the main axis direction of the liquid crystal molecules changes (twist and tilt) successively, even if the liquid crystal orientation direction on the substrate interface with regard to the measuring polarization is known, the value of the refractive index of the cell cannot be define easily.

[0006] Thus, the prior art liquid crystal cell thickness measuring method has the serious problem that although the optical path difference can be measured, the value of the gap cannot be calculated.

[0007] A cell having single axis orientation suffers from a similar problem when it has a pre-tilt angle θ (refer to Figure 7).

[0008] The present invention has been contrived in view of the above-mentioned prior art problems, and has the purpose of providing a liquid crystal cell thickness measuring method enabling correct measurement of the gap.

[0009]

[MEANS TO SOLVE THE PROBLEMS] In order to achieve the above-mentioned object, in the liquid crystal cell thickness measuring method of the present invention, a pair of glass

substrates having transparent electrodes on their inner surfaces is bonded by a sealing material; a liquid crystal of positive dielectric anisotropy is injected between the pair glass substrates; and when the gap of the liquid crystal cell is measured, a high voltage not smaller than 50 times the threshold voltage or a high magnetic field not smaller than 50 times the threshold magnetic field is applied to the liquid crystal cell.

[0010]

[ACTION] Since the measurement of the gap is done while a high voltage is being applied to the liquid crystal cell, the refraction index of the liquid crystal cell can be defined. Consequently, correct measurement of the gap can be done in such modes as TN, STN, pre-tilt orientation cell, etc.

[0011]

[EMBODIMENT] The present invention makes use of the property of liquid crystal that when an electric field is applied on a liquid crystal of positive dielectric anisotropy, the liquid crystal molecules are aligned in the electric field direction, and shows a method for measuring the gap of the liquid crystal cell in which the liquid crystal molecules are in horizontal or pre-tilt orientation (regardless of the presence or absence of twist orientation) with the use of a liquid crystal of positive dielectric anisotropy.

[0012] The embodiment will be described with reference to Figures 1 and 2. A pair of glass substrates 10 has transparent electrodes 40 on their inner surfaces, and the pair glass substrates 10 are bonded with each other by a sealing material 50, and a liquid crystal 60 of positive dielectric anisotropy is injected between the pair glass substrates 10.

[0013] In addition, a detector 80 is disposed above the cell, and an alternating voltage 90 is disposed on the transparent electrodes 40

to be applied thereon.

[0014] Furthermore, a reflection measuring light 70b and a transmittance measuring light 70a are applied from the top side and the bottom side, respectively.

[0015] A. By the way, as shown in Figure 2, when a high electric field is applied to the transparent electrodes 40, almost all of the liquid crystal molecules 20 inside the liquid crystal cell are realigned in the electric field direction, that is, in the direction of the normal to the glass substrates 10. Thus, when the electric field is weak, the liquid crystal molecules 20 in the vicinity of the substrate interface are aligned in the direction close to the initial alignment due to the anchoring force of the interface. On the other hand, when the electric field is powerful, the thickness 30 of this part becomes as thin as to be ignorable as compared with the cell thickness.

[0016] Therefore, in order to meet the above-described requirements, a high voltage not smaller than 50 times the threshold voltage or a high magnetic field not smaller than 50 times the threshold magnetic field is applied to the liquid crystal cell.

[0017] B. Next, under the same conditions as A, the cell thickness is measured in the same manner as the prior art method so as to determine the optical path difference.

[0018] C. Under the conditions of A, the refractive index of the liquid crystal cell becomes the refractive index of the normal light direction of the liquid crystal whichever direction polarized incident light comes from as long as it is in the vertical direction of the cell. Therefore, the optical path difference obtained at B can be divided by this value to find the thickness of the liquid crystal cell.

[0019] In a cell having vertical orientation, this method is effective as long as the dielectric anisotropy of the liquid crystal 60 is positive.

[0020]

[EFFECTS OF THE INVENTION] The present invention can be constituted and the refractive index of the liquid crystal cell can be defined as described above. As a result, correct measurement of the gap can be done even in a mode where the cell gap measurement is difficult such as TN, STN, or pre-tilt orientation cell.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIGURE 1] A schematic diagram of the measuring method of the present invention.

[FIGURE 2] A diagram explaining the arrangement state of the liquid crystal of the present invention.

[FIGURE 3] A schematic diagram of the prior art measuring method.

[FIGURE 4] A diagram explaining the molecular arrangement of a homogeneous orientation cell.

[FIGURE 5] A diagram explaining the molecular arrangement of a TN cell.

[FIGURE 6] A diagram explaining the molecular arrangement of a STN cell.

[FIGURE 7] A diagram explaining the molecular arrangement of a pre-tilt angle cell.

[EXPLANATION OF THE REFERENCE NUMBERS]

10 glass substrates

20 liquid crystal molecules

40 transparent electrodes

50 sealing material

60 liquid crystal

70a measuring light (reflection)

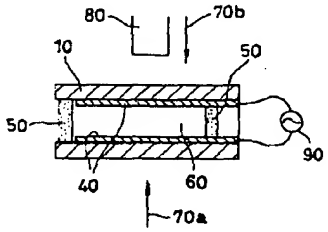
70b measuring light (transmittance)

80 detector

(54) **THICKNESS MEASURING [illegible]OD OF LIQUID CRYSTAL CELL**
(11) 5-71924 (A) (43) 23.3.1993 (19) JP
(21) Appl. No. 3-258593 (22) 9.9.1991
(71) STANLEY ELECTRIC CO LTD (72) TAKASHI SUGIYAMA
(51) **Int. Cl⁵. G01B11/06,G02F1/1339**

PURPOSE: To obtain a liquid crystal cell thickness measuring method enabling correct measurement of a gap.

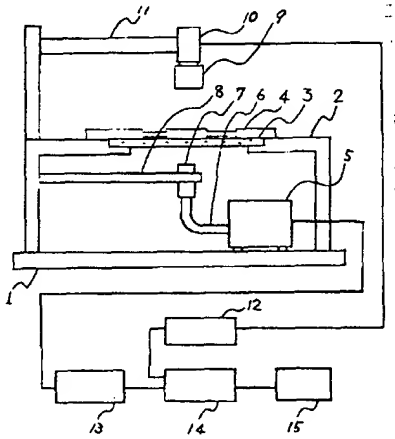
CONSTITUTION: A pair of glass substrates 10 having transparent electrodes 40 thereinside are bonded by a sealing material 50. At the same time, a liquid crystal of positive dielectric anisotropy is injected between the glass substrates 10. When a gap of the liquid crystal cell is measured, a high voltage not smaller than 50 times the threshold voltage or a high magnetic field not smaller than 50 times the threshold magnetic field is applied to the liquid crystal cell.



(54) **THICKNESS MEASURING APPARATUS OF SILICON PLATE**
(11) 5-71925 (A) (43) 23.3.1993 (19) JP
(21) Appl. No. 3-233384 (22) 12.9.1991
(71) SEIKO EPSON CORP (72) TOSHIHIRO SAITO
(51) **Int. Cl⁵. G01B11/06**

PURPOSE: To obtain an inexpensive apparatus which can measure the thickness of a silicon plate accurately even when the silicon plate is wet or when the surface is rough in a selective manner of a minute area and a large area.

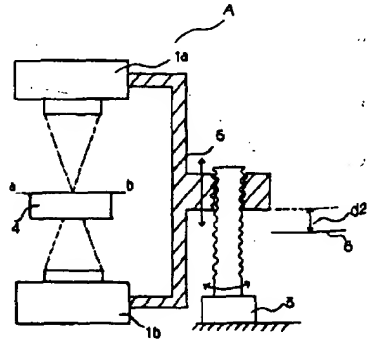
CONSTITUTION: A light source is arranged at one side of a silicon plate 4 to be measured, and a photosensor 9 is set at the other side of the silicon plate 4, confronting the light source. The light passing through the silicon plate 4 is detected by the photosensor, and the thickness of the silicon plate 4 is predicted from the value of the amount of light.



(54) **THICKNESS-MEASURING SYSTEM**
(11) 5-71926 (A) (43) 23.3.1993 (19) JP
(21) Appl. No. 3-263166 (22) 13.9.1991
(71) MITSUBISHI ELECTRIC CORP (72) IHEI SUGIMOTO
(51) **Int. Cl⁵. G01B11/06**

PURPOSE: To obtain a thickness-measuring system which enables an error to reduce and at the same time can be realized by a simple configuration and an inexpensive device by constituting the device with a simple drive device.

CONSTITUTION: A title item is provided with two television cameras 1a and 1b which are positioned oppositely so that a focus is formed on a same plane a-b and an arm 5 whose position is adjusted so that the television cameras 1a and 1b are vertical for the plane a-b. A device 4 to be measured is positioned so that one plane of the device 4 to be measured coincides with a surface of the plane a-b and the television cameras 1a and 1b are moved in thickness direction of the device 4 to be measured with the plane a-b as an origin. A traveling distance d2 until the focus of one television camera 1a which is positioned at a side of this traveling coincides with the other surface of the device 4 to be measured is obtained a thickness of the device 4 to be measured.



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Ｇ０１Ｂ	11/06		G 7625－２Ｆ		
Ｇ０２Ｆ	1/1339	５００	7724－２Ｋ		

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(21)出願番号　特願平3-258593

(22)出願日　平成3年(1991)9月9日

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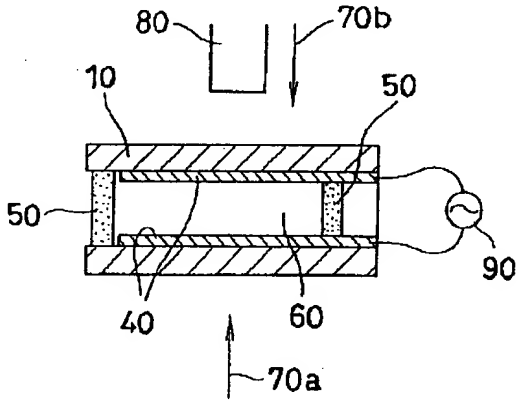
(54)【発明の名称】液晶セルのセル厚測定方法

(57)【要約】
【目的】この発明は、正確なギャップ測定が可能な液晶セルのセル厚測定方法を目的にしている。
【構成】内面に透明電極４０を有する一対のガラス基板１０をシール材５０で接着すると共に、該一対のガラス基板１０間には誘電率異方性が正の液晶６０を注入し、液晶セルのギャップ測定時に、該液晶セルにしきい電圧の５０倍以上の高電圧若しくはしきい磁界の５０倍以上の高磁界をかけながら測定して成る。



1

【特許請求の範囲】

【請求項１】内面に透明電極を有する一対のガラス基板をシール材で接着すると共に、該一対のガラス基板間には誘電率異方性が正の液晶を注入し、液晶セルのギャップ測定時に、該液晶セルにしきい電圧の５０倍以上の高電圧若しくはしきい磁界の５０倍以上の高磁界をかけながら測定して成る液晶セルのセル厚測定方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、液晶表示セルに利用される液晶セルのセル厚測定方法に関するものである。

【０００２】

【従来の技術】従来の液晶セルの構造は、図３に図示したように、一対のガラス基板１をシール材２で接着し、該一対のガラス基板１間には液晶３が注入してあり、上方にはディテクター５を配置し、上側からは反射測定光４ｂを、下側からは透過測定光４ａを照射している。

【０００３】そして、光干渉法等を用いて液晶３注入後のセル厚を測定する場合は、測定光４ａ、４ｂが偏光を含む時、該偏光に対する液晶セルの方向を決めて透過光スペストルを測定して液晶セルの光学的光路差を求め、その偏光方向に対応する液晶の屈折率で割ることによりセル厚を求めている。

【０００４】なお、上記屈折率は、例えば、ホモジニアス配向したセル（図４参照）では、ガラス基板１間で、偏光方向と液晶分子３ａの主軸方向が平行な場合には、その液晶分子３ａの異常光に対する屈折率であり、また、ガラス基板１間で、偏光方向と液晶分子３ａの主軸方向が直交する場合には、常光に対する屈折率をいう。

【０００５】

【発明が解決しようとする課題】しかし、ホモジニアス配向のセルでは、その主軸の方向を決めることによって、そのセルの屈折率を規定することが可能であるが、例えばＴＮセル（図５参照）や、ＳＴＮセル（図６参照）の場合は、液晶分子の主軸方向の空間分布が連続的に変化（ツイストとテイルト）しているため、例え測定偏光に対する基板界面の液晶配向方向が判っているとしても、そのセルの屈折率の値を簡単に規定することができない。

【０００６】従って、従来の液晶セル厚測定方法では、光学的光路差は測定できても、ギャップの値を計算できないという大きな問題点がある。

【０００７】また、一軸配向のセルの場合も、プレテイルト角θ（図７参照）を有するときは、同様な問題点がある。

【０００８】そこで、本発明は、上記従来の技術の問題点に鑑み案出されたもので、正確なギャップ測定が可能な液晶セルのセル厚測定方法の提供を目的としている。

【０００９】

【課題を解決するための手段】上記目的を達成するため

2

に、本発明における液晶セルのセル厚測定方法においては、内面に透明電極を有する一対のガラス基板をシール材で接着すると共に、該一対のガラス基板間には誘電率異方性が正の液晶を注入し、液晶セルのギャップ測定時に、該液晶セルにしきい電圧の５０倍以上の高電圧若しくはしきい磁界の５０倍以上の高磁界をかけながら測定して成るものである。

【００１０】

【作用】ギャップ測定時に、該液晶セルに高電圧をかけながら測定を行うため、液晶セルの屈折率が規定できる。従って、ＴＮ，ＳＴＮ、プレテイルト配向セル等モードにおいても、正確なギャップ測定ができる。

【００１１】

【実施例】本発明は、誘電率異方性が正の液晶に電界をかけた場合、液晶分子が電界方向を向くという性質を利用したものであり、誘電率異方性が正の液晶を用いて該液晶分子が水平若しくはプレテイルト配向（ツイスト配向の有無は問わない）している液晶セルのギャップ測定方法である。

【００１２】次に、実施例について図１から図２を参照して説明すると、一対のガラス基板１０の内面には、透明電極４０が配設してあり、該一対のガラス基板１０同士はシール材５０で接着し、ガラス基板１０間には誘電率異方性が正の液晶６０が注入されている。

【００１３】また、上方にはデイテクター８０を配置し、透明電極４０には交流電圧９０が印加可能に配置されている。

【００１４】さらに、上方からは反射測定光７０ｂ、下側からは透明測定光７０ａが照射されている。

【００１５】Ａ．ところで、図２に図示したように、透明電極４０に高電界をかけた時は、液晶セル内の液晶分子２０の殆どは、該電界方向にすなわち、ガラス基板１０に対し法線方向に再配列する。すなわち、電界が弱いときには、界面のアンカーリング力により，基板界面付近の液晶分子２０は初期配向の方向に近い方向に配向しているが、電界が強いときには、このような部分の厚さ３０が、セル厚に比べて無視できる程薄くなる。

【００１６】そこで、上記条件にするために、液晶セルにしきい電圧の５０倍以上の高電圧若しくはしきい磁界の５０倍以上の高磁界をかけるようにしている。

【００１７】Ｂ．次に、上記Ａと同様な条件下で、従来と同様な方法でセル厚を測定し光学的光路差を決定している。

【００１８】Ｃ．また、上記Ａの様な条件下では、セルの垂直方向であれば、如何なる方向から入射する偏光に対しても、該液晶セルの屈折率は該液晶の常光方向の屈折率になるため、この値でＢで求めた光学的光路差を割ることにより、該液晶セルのセル厚を求めることができる。

【００１９】なお、垂直配向したセルに於いても、液晶

3

６０の誘電率異方性が正である限り、此の方法は有効である。

【００２０】

【発明の効果】本発明は、上述の通り構成され、液晶セルの屈折率が規定できるため、セルギャップ測定が困難なモードのＴＮ，ＳＴＮ、プレテイルト配向セル等においても正確なギャップ測定ができる。

【図面の簡単な説明】

【図１】本発明の測定方法の概略図である。

【図２】本発明の液晶の配列状態の説明図である。

【図３】従来の測定方法の概略図である。

【図４】ホモジニアス配向セルの分子配列説明図である。

4

【図５】ＴＮセルの分子配列説明図である。

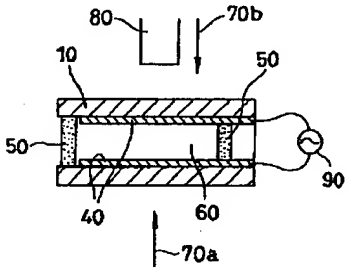
【図６】ＳＴＮセルの分子配列説明図である。

【図７】プレテイルト角セルの分子配列説明図である。

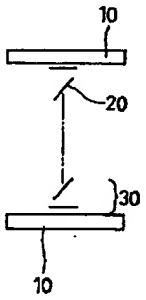
【符号の説明】

１０　ガラス基板
２０　液晶分子
４０　透明電極
５０　シール材
６０　液晶
７０ａ　測定光（反射）
７０ｂ　測定光（透過）
８０　ディテクター

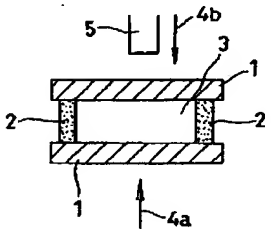
【図１】



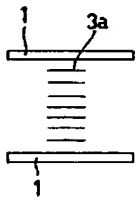
【図２】



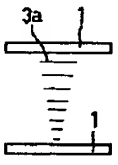
【図３】



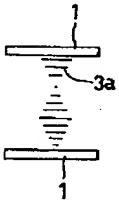
【図４】



【図５】



【図６】



【図７】